

N 69 2362 2
NASA CR 100636

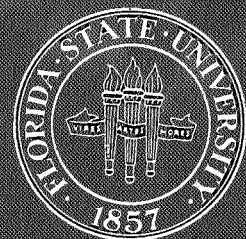
PROGRESS REPORT: NASA GRANT NGR-10-004-029 to
THE FLORIDA STATE UNIVERSITY

PROJECT TITLE: Biostatistics and Space Exploration:
Microbiology and Sterilization

PRINCIPAL INVESTIGATOR: Richard G. Cornell

DATE: April 1, 1969

**The Florida State University
Department
of
Statistics
Tallahassee, Florida**



**PROGRESS REPORT: NASA GRANT NGR-10-004-029 to
THE FLORIDA STATE UNIVERSITY**

**PROJECT TITLE: Biostatistics and Space Exploration:
Microbiology and Sterilization**

PRINCIPAL INVESTIGATOR: Richard G. Cornell

DATE: April 1, 1969

**Department of Statistics
The Florida State University
Tallahassee, Florida 32306**

by N. J. Petersen, R. G. Cornell and J. R. Puleo which has been presented at professional meetings and has been accepted for publication by Space Life Sciences.

In the initial analysis a maximum likelihood estimate of the only parameter involved was computed for each of four fracture areas studied using observed proportions of fractured plaster discs showing growth of bacterial spores and corresponding experimentally determined concentrations. The concentrations were assumed to be known without error. The model involved binomial variation of observed proportions of positive discs about expectations of the form $P_1 = 1 - \exp.(-\lambda\theta_1 A)$, where λ is the parameter to be estimated, θ_1 is the true concentration and A is the fracture area exposed. When the model was evaluated using the calculated parameter estimates it was found that it did not describe the data adequately, and it appeared that the difficulty was in the measurement of the concentrations instead of in the form of P_1 or of assumptions concerning binomial variation about the P_1 .

This conclusion, which was initially based only on visual inspection of departures from the model, has been borne out in further work reported in Technical Report 17 by Richard G. Cornell which accompanies this Progress Report. In this report the fact that two sets of tubes were prepared from many of the plastic rods, and, therefore, that for many batches there were two observed proportions of discs showing growth, has been used to verify that, in fact, the variation of observed proportions for a given concentration is like that which would be expected with a binomial distribution as assumed in the model. Secondly, an estimation procedure is developed for the

concentrations which utilizes the observed proportions of positives as well as the observed concentrations. Subsequent calculations like those carried out initially are illustrated and lead to practically the same estimates of the model parameter and its standard error, but dramatically reduce the chi-square statistic used to test the appropriateness of the model to a value somewhat less than its expectation. Hence, this analysis confirms the adequacy of the model used in initial analysis, and as a by-product, yields improved concentration estimates.

Technical Report 17 is also being sent to Mr. Petersen and it is anticipated that it will be submitted to Biometrics for publication with Mr. Petersen as co-author. It will also be presented as an invited paper at the April, 1969 meetings of the Biometric Society in Iowa City by Richard G. Cornell. The report contains illustrative calculations for only one of the four fracture areas used in the original experiment. Calculations for all of the four areas are given in a letter to Mr. Petersen, a copy of which is included at the end of this Progress Report.

Planetary Quarantine Probability Models

Technical Report 14, "Biological losses and the quarantine policy for Mars" by S. Eric Steg has been accepted for publication in Space Life Sciences. Another report, dealing with a plot removal sampling model which is appropriate for estimating the size of a population for a large area and at the same time determining which plots within this area are empty, is nearing completion. The results in this report would be helpful in evaluating spacecraft test procedures aimed at estimating the bioburden and simultaneously identifying, with high probability, sterile components.

Statistical Procedures for Microbial Assays and Related
Nonlinear Statistical Estimation Techniques

Work by Richard G. Cornell is continuing on a manuscript entitled "Estimation of the parameters in exponential decontamination models".

Several such models have been developed. Both the models and estimation procedures for the corresponding parameters, as well as a description of the usefulness of these estimates in the determination of decontamination standards, have been described in a form appropriate for publication. Calculations for a final section containing examples of the use of the procedures described on actual decontamination data are still underway. When the manuscript is completed it will be sent to NASA and submitted for publication in a professional journal.

Technical Report Number 10, entitled "Simultaneous estimation by partial totals for compartmental models", by John J. Beauchamp and Richard G. Cornell has been published in the June, 1968 issue of the Journal of the American Statistical Association. Technical Report 13, "Certain uncorrelated nonparametric test statistics" by Myles Hollander, was published in the same issue. Reprints of these papers were sent to NASA on October 11, 1968. Another technical report by Beauchamp and Cornell, Number 9: "Spearman simultaneous estimation for a compartmental model", has been accepted for publication by Technometrics. It was originally scheduled to appear in the February, 1969 issue but its publication has been delayed until May, 1969. Reprints of this paper will be sent to NASA as soon as they are available.

The work of Duane A. Meeter, Walter R. Pirie and William J. Blot on "A comparison of two model-discrimination criteria" has been completed

and accompanies this Progress Report as Technical Report 16. This manuscript has been accepted for publication in Technometrics. Reprints of this paper will also be sent to NASA when they are available.

On another research project, Gerald van Belle has developed a method of analyzing tabular count data such as arise in decontamination experiments which is an alternative to the usual chi-square test of independence. He has shown that it is better than the usual test but only sometimes better than other possible competitors. He has carried out extensive analytical and computational work and has completed this research. Two articles based on this work are being written and will be sent to NASA as technical reports and submitted to statistical journals for publication.

THE FLORIDA STATE UNIVERSITY
Tallahassee 32306

Department of Statistics

April 9, 1969

Mr. Norman J. Petersen
Senior Sanitary Engineer
National Communicable Disease
Center
4402 North Seventh Street
Phoenix, Arizona 85014

Dear Norm:

Enclosed is a draft of a paper on the evaluation of the model we used in the initial analysis of your fracture data. The paper includes illustrative calculations for 30.6 mm^2 only. The conclusions hold for all four areas studied. Included with this letter are Tables 1, 2, 3 and 4. Table 1 is the same as Table 1 in the paper. Tables 2, 3 and 4 contain the corresponding results for 61.2 , 91.8 and 122.4 mm^2 , respectively. In addition to these results, we have computer lists of the $\hat{\theta}_1$ concentration estimates for each area. I do not think these are of any particular interest to you, but if they are let me know and I will send them to you. Also, we have chi-square statistics of 34.2 and 12.3 , each with 32 degrees of freedom, to test the binomial variation assumption for 61.2 and 91.8 mm^2 , respectively, which indicate that this assumption is appropriate for these areas as it was found to be for 30.6 mm^2 in the paper. We cannot test this assumption for 122.4 mm^2 because paired proportions were not obtained for that area.

The goodness-of-fit statistics reported here for 30.6 , 61.2 and 122.4 mm^2 and all of the estimation calculations agree within rounding error when \bar{x}_1 concentration estimates are used with those given in my

Page 2
Mr. Norman J. Petersen
April 9, 1969

original report letter of March 1, 1968. The corresponding goodness-of-fit statistic reported here for 91.8 is considerably less than that reported earlier. In the initial data list you reported a concentration of 4.6 for batch 39 for 84 mm^2 . When you later sent the paired concentration determinators it became evident that this should have been reported as 7.6, which improved the fit for that area so that the goodness-of-fit statistic is not significant at the five per cent level of significance. Fortunately, this does not alter the estimation of λ for practical purposes and the conclusions in both papers still hold.

I plan to present this paper as an invited address at the meetings of the Biometric Society at Iowa City later this month. Please let me know of your suggested changes in the paper. After incorporating them in the paper, I plan to submit the paper to Biometrics for publication.

Sincerely yours,

Richard G. Cornell
Professor
Department of Statistics

RGC/cm

Enclosures

TABLE 1

GOODNESS-OF-FIT AND ESTIMATION CALCULATIONS FOR THREE MEASURES OF CONCENTRATION

30.6 mm²

	Concentration Estimates		
	\bar{x}_i	u_i	$\hat{\theta}_i$
χ^2 (107 degrees of freedom)	172.8	178.9	93.0
$\hat{\lambda}$	3.18	3.24	3.23
$\sqrt{\hat{V}(\hat{\lambda})}$	0.119	0.122	0.121

TABLE 2

GOODNESS-OF-FIT AND ESTIMATION CALCULATIONS FOR THREE MEASURES OF CONCENTRATION
 61.2 mm^2

	Concentration Estimates		
	\bar{x}_i	u_i	$\hat{\theta}_i$
χ^2 (99 degrees of freedom)	241.1	255.3	77.1
$\hat{\lambda}$	2.90	2.95	3.01
$\sqrt{\hat{V}(\hat{\lambda})}$	0.106	0.108	0.110

TABLE 3

GOODNESS-OF-FIT AND ESTIMATION CALCULATIONS FOR THREE MEASURES OF CONCENTRATION
 91.8 mm^2

	Concentration Estimates		
	\bar{x}_1	u_1	$\hat{\theta}_1$
χ^2 (63 degrees of freedom)	72.6	73.0	37.9
$\hat{\lambda}$	3.08	3.11	3.18
$\sqrt{\hat{V}(\hat{\lambda})}$	0.135	0.137	0.139

TABLE 4

GOODNESS-OF-FIT AND ESTIMATION CALCULATIONS FOR THREE MEASURES OF CONCENTRATION
 122.4 mm²

	Concentration Estimates		
	\bar{x}_i	u_i	$\hat{\theta}_i$
χ^2 (32 degrees of freedom)	36.2	36.6	15.5
$\hat{\lambda}$	3.08	3.11	3.15
$\sqrt{\hat{V}(\hat{\lambda})}$	0.185	0.187	0.189